Physics Flash

August 2012

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Steven Elliott

Going deep in the quest to find the elusive neutrino

By Diana Del Mauro
ADEPS Communications

Los Alamos nuclear physicist Steven Elliott has been a behind-the-scenes champion of underground research for nearly three decades. His influence on the field, however, is just coming to light.

Elliott has been a key player in the creation of the nation's only laboratory that adequately blocks cosmic background radiation for sensitive physics experiments, the Sanford Underground Research Facility (SURF), located 4,850 feet below the surface in Lead, South Dakota.

Kevin Lesko, who heads the SURF operations office and the 200 scientists who will soon go to work in the abandoned gold mine, said Elliott "has not received all the credit he deserves for his contributions."

Elliott played a prominent role on committees in Washington, D.C., and elsewhere that rallied for an underground lab in the United States that would provide an unprecedented environment for unlocking secrets about the structure and processes of the universe.

As one of only six scientists chosen to lay the experimental groundwork for the new lab, Elliott "translated the experimental instrument sensitivities into environmental requirements," including calling for 5,000 pounds of the world's purest copper to shield the experiments, "ultimately permitting us to design rooms at SURF to house the experiments," Lesko said.

Underground labs serve a broad swath of science, yet Elliott's interest in such hot, windowless places flows from his passion for

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Worker Safety and Security Teams

WSST stands for worker safety and security team; the key word being "worker." Although one might think WSSTs are just another of the many "safety things" we are required to do and dismiss them as trivial, WSSTs are, however, an opportunity to have a say in how we treat safety and security at the Lab. This is what the "worker" in WSST means. We are a team run by the workers in collaboration with management.

In December 2005 Los Alamos National Security (LANS) was awarded the contract to manage and operate Los Alamos National Laboratory. As part of the proposal, LANS set as a goal attaining Department of Energy Voluntary Protection Program (VPP) Star Status. Star recognition is the highest achievement level in the VPP and recognizes outstanding safety and health programs. VPP's main tenant is that management and workers come together to solve long standing, as well as short-term, safety and health problems present in the everyday workplace. As part of working towards VPP certification, the institutional WSST was formed late in 2006.

The worker is the expert at how to improve safety and security in his or her workplace. These improvements may include easy access to needed tools, well-maintained parking lots and sidewalks, or repair and maintenance of the facilities in which we work. As workers we may be frustrated and discouraged at the perceived lack of interest in our workplace's condition and the difficulties in our ability to address these problems. We seem to be required to read more and more documents to address safety compliance, but have seen little participation in actually solving existing problems.
Our directorate's WSSTs actively try to solve these problems. ADEPS management is active and supportive, and while financial constraints limit what can be done to solve problems, it has been effective in solving many problems in the past few years. Below are some of the many accomplishments due to WSST involvement.

Problems solved due to solutions teams walk arounds include

- Emergency lights are in the process of being installed in a lab at MST. The lab is very dark with the lights off and would be dangerous in the case of a power failure
- Mystery circuit breakers in a lab were identified, supplying power for instruments in that lab
- A faulty plug in behind a glove box was discovered and repaired
- Electrical safety refresher courses were surveyed. The results were given to instructors in hopes that classes can be refurbished to better meet our needs.
- Crosswalk signage was placed in more obvious places at TA-53 to enhance safety.
- Trees that were intrusive to walkways have been trimmed. A dead tree in front of the Materials Science Laboratory was cut down after WSST intervention. It took further intervention to get it removed.
- Additional cell phone boxes placed at TA-3 in a timely manner
- WSST facilitated repair of exterior lighting along pedestrian path at TA-35 within 2 days.
- Coordinated with ice and snow removal teams to increase removal efforts in problem parking and pedestrian walk areas.
- A mess of ice and mud left in the government vehicle parking spots left after fire hydrant repair was cleaned up after WSST intervention.

These are just a few of the many accomplishments of the WSSTs in your directorate. We would like to add more to the list, which could be accomplished with more participation among the workers. Please get to know the WSST reps in your groups and work with them on problems that exist. They may be able to help you.

The photos on the next page are of your division reps. Can you match the name and face to your division? If you don't know the rep in your group, the face you see can tell you who he or she is. Get to know your group rep, or even better, become your group rep or alternate rep. With help from workers we can shed light on problems that need fixing at the worker level, and get some of them solved.

The ADEPS WSST

Take the

Take the 'Know your Worker Safety and Security Team rep'

QUIZ!

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KEY: A7, B4, C6, D3, E1, F2, G5

the neutrino, the fast-moving, elusive particle discovered in 1956 by Los Alamos scientists Fred Reines and Clyde Cowan Jr.

"In some ways neutrinos are a simple particle, but we don't know much about them, and that makes a fascinating story," said Elliott, the Weak Interactions team leader in Neutron Science and Technology (P-23).

Neutrinos have been crawling everywhere in the universe since the dawn of time—as close as the finger that scratches your head—but they escape easy detection and remain unexplained by the Standard Model of elementary particle physics.

Los Alamos has set research aimed at a better understanding of the Standard Model as one of its grand scientific challenges. As well, the research "pushes the state of the art of radiation detection and therefore underpins the basic science of many of the Lab's applied missions," Elliott said.

"One primary question in science is why the universe is made of matter with almost no antimatter," said Elliott, who has a PhD in physics from the University of California, Irvine, and is a fellow of the American Physical Society. One answer would be that neutrinos turn out to be their own anti-particles. Research at SURF aims to find out.

Through the Majorana project, an international team of researchers will search for evidence of the extremely rare process of neutrinoless double-beta decay. If this decay occurs, then neutrinos are their own antiparticles–or Majorana particles.

"Steve is probably the best-known and best-versed physicist in the U.S. in neutrinoless double-beta decay, both experimental, and to a large, extent theoretical," Lesko said.

The initial stage includes a small demonstrator laboratory using Los Alamos-tested germanium detectors. During the four-year experiment, Elliott will monitor the Majorana Demonstrator project and help analyze the data it produces.

"We must prove that a large double-beta decay experiment would be feasible and what it would take to build a big experiment," he said. "Is it deep enough? We hope we'll know the answer to that."

SURF was planned to be 7,400 feet underground, which would have made it the world's deepest laboratory, but budget changes altered the scope.

"That battle isn't finished yet," Elliott said.

Elliott's favorite experiment

What: The first laboratory measurement of two-neutrino double beta decay

When: 1987

Where: University of California, Irvine

Who: Steve Elliott, Alan Hahn, Michael Moe

Why: In some nuclei, beta decay is forbidden, but double beta decay where two beta particles are emitted is possible. This process was predicted in the 1930s but had not been observed in the laboratory. The reason for the difficulty is that the half-life is so long. In fact, this process is still the slowest nuclear decay measured in the laboratory.

How: We built a device that could observe tracks made by the two electrons emitted from a thin foil of selenium that was enriched in the isotope that was predicted to double beta decay.

The a-ha moment: The rate of double beta decay is very slow and our selenium sample was only 14 grams. After about 2 years of data taking we had data that indicated an observed rate of 2 events per week. When we did the analysis that showed the events had the characteristics of double beta decay, it was a very exciting time. We all traveled to a conference in New Orleans to present the results. At the time there were many experiments trying to measure the same thing and being first was very exciting. The work was published in *Physical Review Letters* and is still discussed today as a seminal piece of research. More modern experiments have confirmed the decay rate we measured.

Canada's SNOLAB grand opening

LANL participates with dark matter experiment MiniCLEAN

In mid-May, the SNOLAB facility, an underground laboratory in Sudbury, Canada, was formally opened. The SNOLAB underground laboratory is an expansion of the original SNO (Sudbury Neutrino Observatory) facility and, at a depth of two kilometers below ground, it is the deepest clean laboratory in the world dedicated to this type of work.

SNOLAB provides an opportunity to conduct experiments in an environment with the lowest possible interference from environmental

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MiniCLEAN . . .

and solar radioactivity. Los Alamos was a major participant in the original SNO experiment and is now assembling a new experiment, MiniCLEAN, in the new SNOLAB facility.

Andrew Hime serves as Spokesperson for MiniCLEAN, and Keith Rielage (both P-23) serves as the project scientist organizing the Los Alamos-led collaboration of 13 institutions in the United States, United Kingdom, and Canada. Rielage represented the experiment at the grand opening of the lab, which included tours for the media and representatives from various funding agencies including the DOE Office of Science High Energy Physics. He also served on the scientific advisory committee for a three-day workshop on underground science held in conjunction with the opening.

MiniCLEAN is a dark matter experiment that utilizes liquid argon to search for weakly interacting massive particles (WIMPs), a possible dark matter particle. Several dark matter experiments are being built and operated at SNOLAB. The Northern Life newspaper produced a video highlighting these dark matter experiments including MiniCLEAN that can be found at: http://www.northernlife.ca/videos/default.aspx?bcpid=77771366001&bctid=1646165601001

The MiniCLEAN Experiment is funded by the LANL LDRD program.

Technical contacts: Keith Rielage, Andrew Hime

World record neutron beam at Los Alamos National Laboratory

New method has potential to advance materials measurement

Using a one-of-a-kind laser system at Los Alamos National Laboratory, scientists have created the largest neutron beam ever made by a short-pulse laser, breaking a world record. Neutron beams are usually made with particle accelerators or nuclear reactors and are commonly used in a wide variety of scientific research, particularly in advanced materials science.

Using the TRIDENT laser, a unique and powerful 200 trillion-watt short-pulse laser, scientists from Los Alamos, the Technical University of Darmstadt, Germany, and Sandia National Laboratories focus high-intensity light on an ultra-thin plastic sheet infused with an isotope of hydrogen called deuterium.

The laser light—200 quintillion watts per square centimeter, equivalent to focusing all of the light coming from the sun to the earth (120,000 terawatts) onto the tip of a pencil—interacts with the plastic sheet, creating a plasma, an electrically charged gas. A quintillion is a one with 18 zeros after it.

The plasma then accelerates large numbers of deuterons–the nucleus of the deuterium atom–into a sealed beryllium target, converting the deuterons into a neutron beam. Using a unique property of plasmas called relativistic transparency, the deuterons are accelerated in just one millimeter rather than the many meters required by standard accelerator technologies.

LANL visiting scientist Markus Roth

"So far only at TRIDENT has this new plasma acceleration mechanism been successfully implemented," said Markus Roth from the Technical University of Darmstadt, who serves as the 2012 Rosen Scholar at the Los Alamos Neutron Science Center (LANSCE). "This result is the world's record for short-pulse laser generated neutron flux, four quintillion neutrons per square centimeter per second for an object one centimeter from the source. In this generation scheme, the neutrons are emitted along the direction of the initial laser beam and can reach very high energies, in excess of 50 million electron volts."

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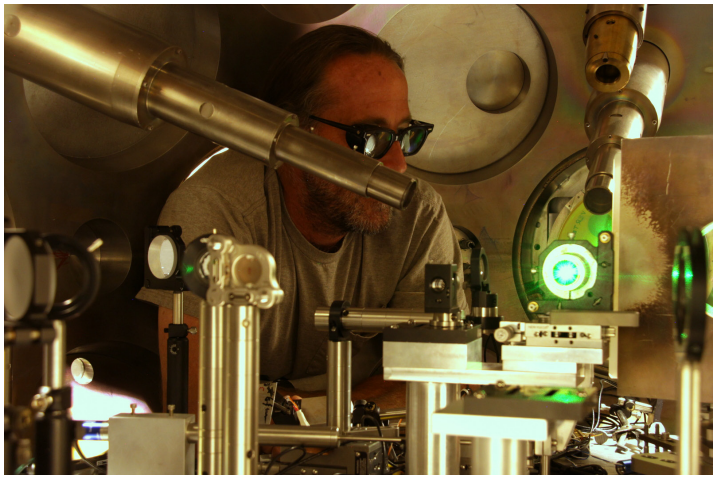
World record . . .

According to Roth, the new record is five times larger than the previous record and required less than a quarter of the laser energy.

"Neutrons are a unique probe with many scientific applications," said Frank Merrill (P-23). "Neutrons are used to study fundamental properties of the universe, advanced materials, and have potential applications such as active interrogation of cargo containers, monitoring for clandestine nuclear explosives at border crossings, and as a test bed for fusion-relevant neutron diagnostics, the initial impetus for this study."



Cort Gautier (P-24) in Trident's north target chamber.

This record neutron beam has the speed and energy range that makes it an ideal candidate for radiography and a wide variety of high-energy-density physics studies.

"An object placed one centimeter behind the source would be exposed to more than 40 neutrons per square micrometer (one millionth of a meter) in less than a nanosecond (one billionth of a second) making it an impressive probe for radiography applications," said Merrill.

"Also, for the first time, in these experiments a neutron image driven by a short-pulse laser was realized and showed excellent agreement with numerical calculations," said Roth. Using short-pulse lasers for the production of neutrons can open the field of neutron research to universities, and a broader research community in general.

This project combined the expertise of LANSCE's neutron science group with Physics Division's plasma physicists, TRIDENT laser scientists, and scientists developing neutron detection diagnostics to be fielded at the National Ignition Facility. Scientists from Sandia provided neutron yield and nuclear activation measurements.

Physics Division researchers win R&D 100 awards

Physics Division researchers Joel Berendzen (Applied Modern Physics, P-21) and David Holtkamp (P-23) are recipients of 2012 "R&D 100" Awards from *R&D Magazine*; Berendzen for his work on Sequedex, and Holtkamp for his work on the Multiplexed Photonic Doppler Velocimeter.

Their awards were two of four R&D 100 awards earned by the Laboratory this year. These awards honor the top 100 proven technological advances of the year, as selected by a group of *R&D Magazine's* chosen judges.

"Congratulations to this year's R&D 100 award winners," said Energy Secretary Steven Chu. "The research and development at the Department of Energy's laboratories continues to help the nation meet our energy challenges, strengthen our national security and improve our economic competitiveness."

"These awards demonstrate the continued success of Los Alamos researchers and partners in defining the frontiers of innovation across a wide range of national security science," said LANL Director Charlie McMillan. "This innovation and creativity will drive the solutions to tomorrow's problems."

Sequedex is a revolutionary software package that can chew through one human genome's worth of DNA analysis in 30 minutes on a single core of a laptop computer. Sequedex makes it possible for a scientist to explore a community of microorganisms by analyzing the DNA from a spoonful of dirt, during the course of an afternoon, using equipment that could be carried on the back of a mule. Sequedex gets its performance boost by combining keyword recognition technology from web search engines with evolutionary theory, placing short "reads" of DNA from any organism on the Tree of Life. In addition to Berendzen, award recipients are Nicolas Hengartner and Judith Cohn (Information Sciences, CCS-3), and Benjamin McMahon (Theoretical Biology and Biophysics, T-6). Holtkamp was a contributor to the multi-laboratory entry "Multiplexed Photonic Doppler Velocimeter (MPDV)," a portable optical

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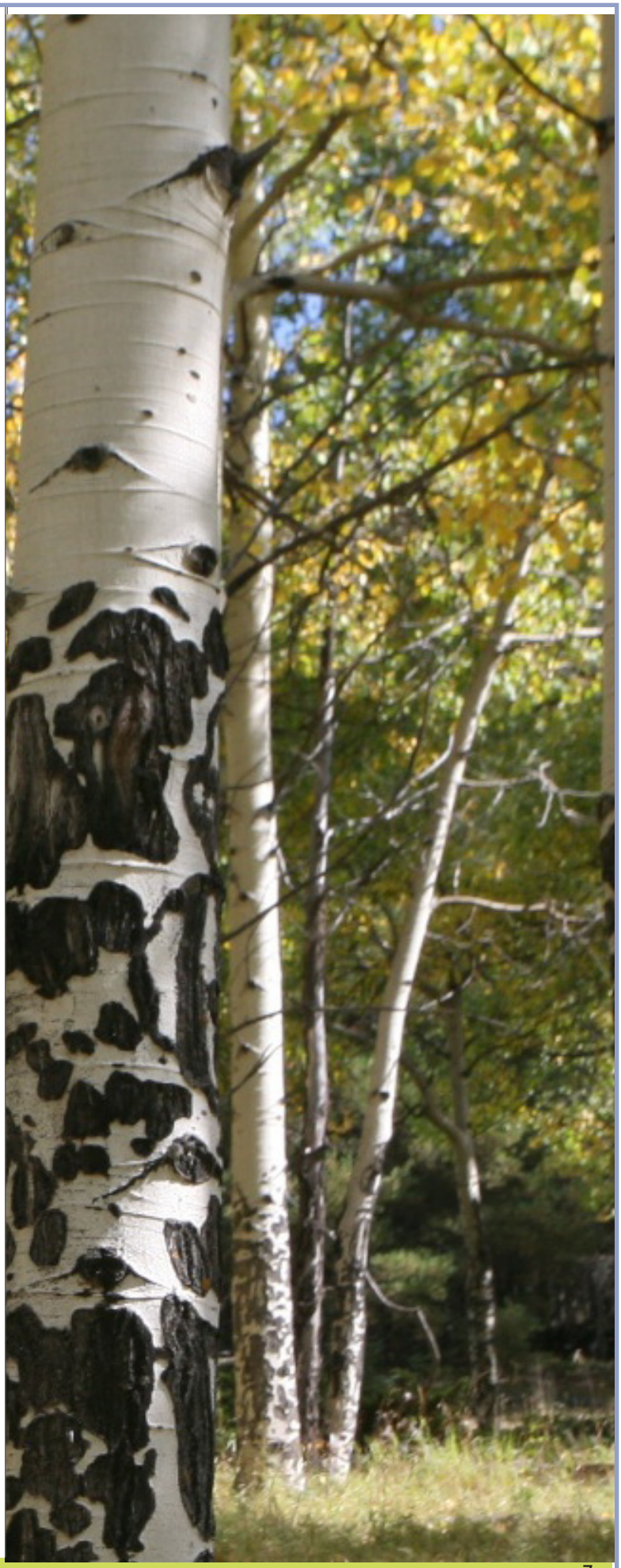
R&D awards . . .

velocimetry system that simultaneously measures up to 32 discrete surface velocities onto a single digitizing oscilloscope by multiplexing signals in frequency and time. A National Security Technologies (NSTec) team led by scientist Ed Daykin, in collaboration with researcher Ted Strand from Lawrence Livermore National Laboratory and David Holtkamp from Los Alamos developed the device which uses Doppler light reflections to measure shock physics properties. This technique can be used to conduct everything from modeling weapons characteristics to the vibrational analysis of auto and aircraft systems.

Since 1978 Los Alamos has won 124 of the prestigious R&D100 awards that celebrate the top 100 proven technological advances of the year as judged by *R&D Magazin*e. These technologies include innovative new materials, chemistry breakthroughs, biomedical products, consumer items, testing equipment, and high-energy physics.

Since 1995, winning innovations have returned more than $45 million in funding to Los Alamos in the form of Cooperative Research and Development Agreements, Work for Others, User Facility Agreements and licenses. More than 80 patent awards have been associated with winners with many more patents pending. More than 25 percent of LANL's commercial licenses and 35 percent of noncommercial licenses can be attributed to R&D 100 winners.

NSTec/LLNL/LANL – MPDV Development Team, 2012 R&D 100 Winner. Left to right: Ed Daykin, David Holtkamp, Howard Bender, David Esquibel, Oliver Ted Strand, Araceli Rutkowski, Cenobio Gallegos, Carlos Perez.



HeadsUP!

UI Division Call Center activated

Utilities and Institutional Facilities (UI) Division has activated a Call Center to help improve and more closely work with tenants to meet their maintenance and facility operation needs. The call center provides another method for requesting services and is a communication tool to clarify delivery expectations that UI can meet and deliver. The Call Center number is 667-2488.

- Through the UI Call Center, employees can
- make requests from UI for reporting facility related problems
- requesting routine maintenance or repairs
- requesting office furniture or equipment moves, etc.

Employees can still make requests through the Facility Request System. Establishment of the call center resulted from feedback provided through a survey UI conducted earlier this year. "The call center will help improve our service delivery. We encourage our customers to contact the call center to inquire on status or expected delivery dates of when work will be performed," said Martin Aguilera, MSS-UI maintenance manager.

Questions? Contact Aguilera at 5-4720.

Proper operation of government vehicles

LANL's fleet is a critical resource to the Laboratory. As summarized below and detailed in the Property Management Manual, there are stringent requirements that must be followed when using a Los Alamos-owned, -rented or -leased motor vehicle:

1. Vehicles may only be used for official purpose by LANL, subcontractors, and other government personnel
2. Operators are allowed to use government vehicles for official travel (in lieu of renting a vehicle), when authorized by a group level manager or higher.
3. In rare circumstances, when an employee must take a government vehicle home, a fully executed Government Vehicle Work-to-Home Approval form is required. Use of the vehicle overnight remains strictly limited to official government business (not commuting). It is not to be used to transport family members or personal items. A new form is required for each trip. More information regarding the proper operation of government vehicles is at the above referenced website link, or contact LANL Property Management at lanlproperty@lanl.gov or 5-3230.

Celebrating service

Congratulations to the following Physics Division employees celebrating service anniversaries this month:

Deborah Morley, P-25	35 years
Jason Medina, P-25	10 years
Brian Hollander, P-25	10 years
Algis Urbaitis, P-21	10 years
John Pretz, P-23	5 years

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